Proposal Number:

A Scientific Web-based Application for Global Tropical Cyclone Monitoring

FY 2001 Proposal to the NOAA HPCC Program

Principle Investigator: Dr. Mark D. Powell

Line Organization: OAR
Routing Code: R/E/AO/HRD
Address:
NOAA/AOML
Hurricane Research Division
4301 Rickenbacker Cswy Miami, FL 33149-1097
Phone: (305) 361-4403
Fax: (305) 361-4402
E-mail Address: Mark.Powell@noaa.gov

Co-Investigator: Nirva Morisseau-Leroy
moriss@aoml.noaa.gov

Proposal Theme: **Crisis / Disaster monitoring or response**

Funding Summary: FY 2001 $40,000.

Authorizing Manager:

_____ Date:_____
Kristina Katsaros, AOML Director

_____ Date:_____
Hugh E. Willoughby, Director, Hurricane Research Division, AOML

_____ Date:_____
Mark D. Powell, PI, Hurricane Research Division, AOML

A Scientific Web-based Application for Global Tropical Cyclone Monitoring

Proposal for FY 2001 HPCC Funding

Prepared by: Mark D. Powell and Nirva Morisseau-Leroy

Executive Summary:

The advent of the Internet has spawned a whole new generation of Web-based applications that allow dynamic interactions with databases. The benefits of a web-based approach include ease of maintenance and development, and centralized distribution of data services. Historically, technologies such as HTML and Common Gateway Interface (CGI) have provided a mechanism for distributing dynamic content over the Web. Web programming techniques have matured rapidly since then to provide enterprise-level functionality, reliability, and scalability in business and scientific applications. Promising and increasingly popular technologies for dynamic content generation include Java servlets and JavaServer Pages (JSPs). These new technologies are part of Java 2 Enterprise Edition (J2EE), which offers a powerful platform on which to build Web-based component applications. We will test the J2EE suite of products by transforming the award-winning Distributed Real-time Hurricane Wind Analysis System (H*WIND) system into a web-based application running over the AOML intranet. Depending on our results, subsequent year's investigation will evaluate the software over the Internet and test the application as a global tool for monitoring tropical cyclones with potential for use in the United Nations World Weather Research Program's International Tropical Cyclone Landfall Program as a Forecast Demonstration Project (FDP).

Problem Statement:

The HRD Real-time Hurricane Wind Analysis System (H*WIND) is a software component application consisting of a suite of scientific objects written in Java using Java Database Connectivity (JDBC) and SQLJ implementations. JDBC provides the capability of embedding dynamic SQL in Java programs whereas SQLJ allows the embodiment of static SQL in Java programs. Today, H*WIND provides atmospheric scientists with the necessary tools to graphically interact with real-time atmospheric observations (from all over the world) and generate real-time analyses of tropical cyclone surface wind measurements. H*WIND was first demonstrated at the NOAA Tech 2000 Conference in October of 1999 where it won the "Best JAVA Implementation" award. The new JAVA version of H*WIND tested thus far this season fully satisfies HRD's requirements as a research tool with operational capabilities. H*WIND is undergoing evaluation this hurricane season by HRD scientists conducting real-time analyses every 3-6 hours in concert with the National Hurricane Center's forecast and warning cycle. In addition, H*WIND has been seeded to NHC for independent testing by hurricane forecasters to examine it's potential as an operational guidance tool. Later this season, we will also be seeding H*WIND to the Department of Defense Joint Typhoon Warning Center for evaluation. H*WIND is a multi-tier

application consisting of a FAT front-client and two back-end engines distributed onto two Unix servers. In a fat client approach, all components live in the client with only the persistent domain data residing on the server.

Whereas the distributed nature of H*WIND and use of JAVA have many advantages in terms of code reuse, hardware independence, and redundancy, the fat client approach has maintenance, distribution, and performance limitations. Information technology resources are extremely limited in government research laboratories, hence economical approaches to performance, data delivery, software maintenance, and distribution are valuable. In fat clients, most of the application or business logic is downloaded to the client. Thus, network traffic is a major burden. Even though the code is written in JAVA, distribution of the H*WIND application would require testing the software to ensure proper operation using various versions of the JAVA Virtual Machine on various operating systems and assisting remote users in getting the software to run properly. Since H*WIND accesses an Oracle8i database, code distribution would require significant investments by recipients desiring their own database infrastructure. We have designed H*WIND as a global tropical cyclone wind field monitoring system. While the modern weather services of the U. S., Japan, Australia, and Europe have access to NOAA's environmental observations through sophisticated IT infrastructures, many developing nations in tropical cyclone areas have little access to these data and even if they did would require significant investment in hardware and software to make use of the data.

The J2EE programming model provides the ability to develop and deploy applications that take advantage of a wide range of new and evolving technologies. Due to its support for distributed applications, J2EE is now being used by many businesses. It solves many of the problems associated with fat clients by distributing data and software applications from a centralized data center over a wide-area network. This model has the potential of making NOAA's data (and software to make use of the data) available to a wide variety of users including weather services of developing nations. With this in mind we have begun discussions with the NWS International Affairs office and the U. S. Agency for International Development (USAID) about exploring the issue. The proposed HPCC research will test the feasibility of this model for scientific applications in a research and operational environment.

This research is consistent with the goal of NOAA's HPCC program to disseminate real-time and historical information to users more completely, in usable forms, and in a timely manner via the Internet. The analysis system will help to fulfill NOAA's strategic plan objective as research to advance short-term warning and forecast services. These uses of storm information are consistent with the findings of the World Disasters Report 1999 issued by the International Federation of Red Cross and Red Crescent Societies (EOS 1999), the National Science and Technology Council symposium "Real-time Monitoring and Warning for Natural Hazards" (EOS 1998), and recent comments by United Nations Secretary General Kofi Annan calling for a "culture of prevention" citing wars and natural disasters as "the major threats to security of individuals and human communities worldwide" EOS (1999). Our research goals are also consistent with the National Academy of Sciences (1996) report, "Computing and Communications in the Extreme" which identified challenges confronting crisis managers, including: 1) "need for cooperation among many different actors", 2) "need to rapidly identify, collect, and integrate crucial information about the developing situation", and 3) "capability to make projections and initiate

actions in the face of an inevitable degree of uncertainty and incompleteness of information".

Proposed Solution:

To overcome fat client limitations and make H*WIND more widely available, we propose to follow the J2EE model to develop a Web-based version of H*WIND. A web application is generally composed of a variety of components. The Web-based version of H*WIND will consist of static components such as HTML pages, and dynamic components such as JavaServer Pages (JSP) and servlets, JavaBeans, Enterprise JavaBeans, and CORBA objects. These dynamic modules can be invoked from servlets or JSPs to provide web-based interaction. We propose also to investigate a Rapid Application Development (RAD) tool such as Web Objects from Apple Computer and/or Oracle JDeveloper for evaluation of various component strategies.

Analysis:

We want to produce a thin-client, multi-tiered application using the Java 2 Enterprise Edition (J2EE) product from Sun Microsystems. In a thin-client application, the logic to access remote objects and databases is removed from the client and moved to an application server or middle-tier server freeing the client from database processing that can be done more efficiently in the server. Another advantage of removing database processing from the client is the reduction of network traffic. With the release of J2EE, the combination of Enterprise JavaBeans (EJB), servlets, and JSP offers a powerful platform on which to build web-based component applications. The EJB effectively encapsulates business logic while the JSP and servlet "front-end" provide the HTTP-based data entry and presentation logic for human interaction.

The advantages of an H*WIND Web-based application are manifold: The thin client architecture distributes much of the design to servers leaving as little code as possible on the client. The result is the reduction of network traffic, faster application downloads, and less client RAM. The thin client is also easier to maintain. With only one version distributed all over the world a wider pool of users can use H*WIND. This is especially important for potential use by developing nations and international regional tropical cyclone forecast centers. Thin Web-based client applications are more economical and efficient than fat, locally based clients. The Web-based version of the H*WIND system will rely on several cutting edge technologies including XML, JAVA servlets, JavaBeans, and JavaServer Pages. Any Web-based application requires the use of HTML, the only language that the Internet understands. HTML tells you how to format a document and does not give any information regarding the content of the document. HTML is used for designing static web pages. To overcome the limitation of HTML, we propose to use the Extensible Markup Language (XML). XML is a way of specifying the content elements of a page to a Web browser. Thus, XML tells you about the content of the document whereas HTML does not.

In multi-tier architecture, Java servlets provide web developers with a simple, consistent mechanism for extending the functionality of a web server and for accessing existing systems. Servlets provide a component-based, platform-independent method for building web-based applications, without the

performance limitations of CGI programs. We propose to remove from the H*WIND client all remote object invocation logic and move it to Java servlets. This should result in increased functionality, network traffic reduction, and better application and system performance.

JavaBeans component architecture extends "Write Once, Run Anywhere" capability to reusable component development. It is used for developing or assembling network-aware solutions for heterogeneous hardware and operating system environments -- within the enterprise or across the Internet. JavaBeans code runs on every OS and also within any application environment. In the Web-based version of H*WIND, we propose to use dynamic web pages versus static pages. JavaBeans allows us to do so. Java code to compute the dynamic content can be conveniently placed in one or more JavaBeans. This separation allows the Java programmer to focus on writing the computing logic in beans, and the HTML programmer to write the presentation format. JSP technology is an extension of the servlet technology created to support authoring of HTML and XML pages. It makes it easier to combine fixed or static template data with dynamic content. A JSP page may generate not just HTML but also XML output. JavaServer Pages (JSP) technology allows web developers and designers to rapidly develop and easily maintain information rich, dynamic Web pages that leverage existing systems. The JSP framework has been designed for use with modular and reusable software components such as JavaBeans. JavaBeans can easily be 'plugged into' a JSP for easy manipulation. The combination of JavaBeans and JSP provides clean separation of the Java logic that generates dynamic content from the presentation logic written in HTML.

Performance Measures:

Milestones
Producing a web-based prototype of the H*WIND system involves two parts:
Months 0-6
Part 1) Developing a back-end query engine to interact with the atmospheric observation database:
a. Evaluation of Rapid Application Development tools such as Web Objects and the Oracle JDeveloper though the
development of a baseline prototype of a small application to query the atmospheric observation database.
b. Develop Java components that encapsulate the query mechanisms to manipulate the atmospheric observation
database. Specifically here, we will investigate distributed component technologies such as JavaBeans, EJB,
and CORBA server objects that may reside in the Oracle8i database (EJB and CORBA objects only) or anywhere over the AOML intranet. While developing the Java components, we will investigate the performance
gain or loss in using JDBC and Oracle SQLJ implementations.

Months 7-12
Part 2) Developing a front-end interface to initiate the queries and dynamically display the results on the web browser:

a. Evaluation of XML, Java servlets and JavaServer Pages (JSPs) for dynamic content generation. Being Java based,
servlets and JSP programs can exploit the full power of the portability, safety, and extensibility of the object oriented Java
platform.

Deliverables

A Web-based prototype of the H*WIND system. Users will be able to display tropical cyclone observations worldwide and interact with the data. Objective analysis of the observations will be one of the first goals in year 2.

Project related References

EOS, 1998: Real-time monitoring and warning for natural hazards can provide real-time benefits. AGU Transactions, p.329.
EOS, 1999: Report warns of more natural disasters. AGU Transactions, 317-319.
EOS, 1999: UN head calls for "culture of prevention" in addressing natural disasters. AGU Transactions, 438.

National Research Council, 1996: Computing and Communications in the Extreme.

Morisseau-Leroy, N., M. Soloman, and G. Momplaisir, 1999: Oracle 8I SQLJ Programming. Osborne McGraw-Hill; ISBN 0072121602.
Morisseau-Leroy, N., J. Basu, and M. Soloman, 2000: Oracle 8I Java Components, Osborne McGraw-Hill; ISBN 0072127376

Budget Summary:

HPCC Contribution:

Contract* Labor:

Co-Investigator: $25K (30%)
Student Programmer: $15K (50%)

Through contract to University of Miami's Cooperative Institute for Marine and Atmospheric Science (CIMAS)

Total Requested from HPCC:

- FY 2001 request $40K
- FY 2002 possible recurring $100K
- FY 2003 possible recurring $100K

HRD Contribution:

PI Labor (25%): $45K
Student Programmer 2: $23K
Hardware and software costs: $10K
Travel and training: $5K

Budget Office Contact
- Administrative Officer: Cathy Steward
- Phone number: (305) 361-4303
- E-mail address: steward@aoml.noaa.gov
- FMC number: 940
